

*Vincent D. Blondel, Eduardo D. Sontag,
M. Vidyasagar and Jan C. Willems*

Open Problems in Mathematical Systems and Control Theory



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Antonio Loría, Françoise Lamnabhi-Lagarrigue, Elena Panteley



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Open Problems in Mathematical Systems and Control Theory Vincent D. Blondel, Eduardo D. Sontag, Mathukumalli Vidyasagar, Jan C. Willems, 2012-12-06 System and Control theory is one of the most exciting areas of contemporary engineering mathematics From the analysis of Watt's steam engine governor which enabled the Industrial Revolution to the design of controllers for consumer items chemical plants and modern aircraft the area has always drawn from a broad range of tools It has provided many challenges and possibilities for interaction between engineering and established areas of pure and applied mathematics This impressive volume collects a discussion of more than fifty open problems which touch upon a variety of subfields including chaotic observers nonlinear local controllability discrete event and hybrid systems neural network learning matrix inequalities Lyapunov exponents and many other issues Proposed and explained by leading researchers they are offered with the intention of generating further work as well as inspiration for many other similar problems which may naturally arise from them With extensive references this book will be a useful reference source as well as an excellent addendum to the textbooks in the area

Unsolved Problems in Mathematical Systems and Control Theory Vincent D. Blondel, Alexandre Megretski, 2009-04-11 This book provides clear presentations of more than sixty important unsolved problems in mathematical systems and control theory Each of the problems included here is proposed by a leading expert and set forth in an accessible manner Covering a wide range of areas the book will be an ideal reference for anyone interested in the latest developments in the field including specialists in applied mathematics engineering and computer science The book consists of ten parts representing various problem areas and each chapter sets forth a different problem presented by a researcher in the particular area and in the same way description of the problem motivation and history available results and bibliography It aims not only to encourage work on the included problems but also to suggest new ones and generate fresh research The reader will be able to submit solutions for possible inclusion on an online version of the book to be updated quarterly on the Princeton University Press website and thus also be able to access solutions updated information and partial solutions as they are developed

Unsolved Problems in Mathematical Systems and Control Theory Vincent D. Blondel, Alexandre Megretski, 2008 This book provides clear presentations of more than sixty important unsolved problems in mathematical systems and control theory Each of the problems included here is proposed by a leading expert and set forth in an accessible manner Covering a wide range

Advances in Mathematical Systems Theory Fritz Colonius, Uwe Helmke, Dieter Prätzel-Wolters, Fabian Wirth, 2012-12-06 This new edited book focuses on the contemporary developments and results in mathematical systems theory and control It is a book in honor of Diederich Hinrichsen for his fundamental contributions and achievements in the fields of linear systems theory and control theory and for his long term achievements in establishing mathematical systems theory in Germany The book includes invited peer reviewed authoritative expositions and surveys of these fields presented by leading international researchers A key theme of

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Advanced Topics in Control Systems

Theory Antonio Loría, Françoise Lamnabhi-Lagarrigue, Elena Panteley, 2006-02-09 This book includes selected contributions by lecturers at the third annual Formation d Automatique de Paris It provides a well integrated synthesis of the latest thinking in nonlinear optimal control observer design stability analysis and structural properties of linear systems without the need for an exhaustive literature review The internationally known contributors to this volume represent many of the most reputable control centers in Europe

Mathematical Problems of Control Theory

Gennadi? Alekseevich Leonov, 2001 This book shows clearly how the study of concrete control systems has motivated the development of the mathematical tools needed for solving such problems In many cases by using this apparatus far reaching generalizations have been made and its further development will have an important effect on many fields of mathematics In the book a way is demonstrated in which the study of the Watt flyball governor has given rise to the theory of stability of motion The criteria of controllability observability and stabilization are stated Analysis is made of dynamical systems which describe an autopilot spacecraft orientation system controllers of a synchronous electric machine and phase locked loops The Aizerman and Brockett problems are discussed and an introduction to the theory of discrete control systems is given

Introduction to Linear

Control Systems Yazdan Bavafa-Toosi, 2017-09-19 Introduction to Linear Control Systems is designed as a standard introduction to linear control systems for all those who one way or another deal with control systems It can be used as a comprehensive up to date textbook for a one semester 3 credit undergraduate course on linear control systems as the first course on this topic at university This includes the faculties of electrical engineering mechanical engineering aerospace engineering chemical and petroleum engineering industrial engineering civil engineering bio engineering economics mathematics physics management and social sciences etc The book covers foundations of linear control systems their raison detre different types modelling representations computations stability concepts tools for time domain and frequency domain analysis and synthesis and fundamental limitations with an emphasis on frequency domain methods Every chapter includes a part on further readings where more advanced topics and pertinent references are introduced for further studies The presentation is theoretically firm contemporary and self contained Appendices cover Laplace transform and differential

equations dynamics MATLAB and SIMULINK treatise on stability concepts and tools treatise on Routh Hurwitz method random optimization techniques as well as convex and non convex problems and sample midterm and endterm exams The book is divided to the sequel 3 parts plus appendices PART I In this part of the book chapters 1 5 we present foundations of linear control systems This includes the introduction to control systems their raison detre their different types modelling of control systems different methods for their representation and fundamental computations basic stability concepts and tools for both analysis and design basic time domain analysis and design details and the root locus as a stability analysis and synthesis tool PART II In this part of the book Chapters 6 9 we present what is generally referred to as the frequency domain methods This refers to the experiment of applying a sinusoidal input to the system and studying its output There are basically three different methods for representation and studying of the data of the aforementioned frequency response experiment these are the Nyquist plot the Bode diagram and the Krohn Manger Nichols chart We study these methods in details We learn that the output is also a sinusoid with the same frequency but generally with different phase and magnitude By dividing the output by the input we obtain the so called sinusoidal or frequency transfer function of the system which is the same as the transfer function when the Laplace variable s is substituted with $j\omega$ Finally we use the Bode diagram for the design process PART III In this part Chapter 10 we introduce some miscellaneous advanced topics under the theme fundamental limitations which should be included in this undergraduate course at least in an introductory level We make bridges between some seemingly disparate aspects of a control system and theoretically complement the previously studied subjects Appendices The book contains seven appendices Appendix A is on the Laplace transform and differential equations Appendix B is an introduction to dynamics Appendix C is an introduction to MATLAB including SIMULINK Appendix D is a survey on stability concepts and tools A glossary and road map of the available stability concepts and tests is provided which is missing even in the research literature Appendix E is a survey on the Routh Hurwitz method also missing in the literature Appendix F is an introduction to random optimization techniques and convex and non convex problems Finally appendix G presents sample midterm and endterm exams which are class tested several times

Mathematical Systems Theory in Biology, Communications, Computation and Finance Joachim Rosenthal, David S. Gilliam, 2012-12-06 Mathematical systems theory is a vibrant research area in its own right The theory has an impact in numerous applications areas including aeronautics biological systems chemical engineering communication systems financial engineering and robotics to name just a few This volume contains survey and research articles by some of the leading researchers in mathematical systems theory Many authors have taken special care that their articles are self contained and accessible also to non specialists The articles contained in this volume are from those presented as plenary lectures invited one hour lectures and minisymposia at the 15th International Symposium on the Mathematical Theory of Networks and Systems held at the University of Notre Dame August 12 16 2002 Mathematical Control Theory II Madhu N. Belur, M. Kanat Camlibel, Paolo Rapisarda, Jacqueliem M.A.

Scherpen,2015-07-08 This treatment of modern topics related to mathematical systems theory forms the proceedings of a workshop Mathematical Systems Theory From Behaviors to Nonlinear Control held at the University of Groningen in July 2015 The workshop celebrated the work of Professors Arjan van der Schaft and Harry Trentelman honouring their 60th Birthdays The second volume of this two volume work covers a variety of topics related to behavioral systems and robust control After giving a detailed account of the state of the art in the related topic each chapter presents new results and discusses new directions As such this volume provides a broad picture of the theory of behavioral systems and robust control for scientists and engineers with an interest in the interdisciplinary field of systems and control theory The reader will benefit from the expert participants ideas on exciting new approaches to control and system theory and their predictions of future directions for the subject that were discussed at the workshop Mathematical Systems Theory I Diederich

Hinrichsen,Anthony J. Pritchard,2011-08-03 This book presents the mathematical foundations of systems theory in a self contained comprehensive detailed and mathematically rigorous way It is devoted to the analysis of dynamical systems and combines features of a detailed introductory textbook with that of a reference source The book contains many examples and figures illustrating the text which help to bring out the intuitive ideas behind the mathematical constructions *Switching in Systems and Control* Daniel Liberzon,2003-06-24 The theory of switched systems is related to the study of hybrid systems which has gained attention from control theorists computer scientists and practicing engineers This book examines switched systems from a control theoretic perspective focusing on stability analysis and control synthesis of systems that combine continuous dynamics with switching events It includes a vast bibliography and a section of technical and historical notes

Control Theory for Partial Differential Equations: Volume 1, Abstract Parabolic Systems Irena Lasiecka,Roberto Triggiani,2000-02-13 Originally published in 2000 this is the first volume of a comprehensive two volume treatment of quadratic optimal control theory for partial differential equations over a finite or infinite time horizon and related differential integral and algebraic Riccati equations Both continuous theory and numerical approximation theory are included The authors use an abstract space operator theoretic approach which is based on semigroups methods and which is unifying across a few basic classes of evolution The various abstract frameworks are motivated by and ultimately directed to partial differential equations with boundary point control Volume 1 includes the abstract parabolic theory for the finite and infinite cases and corresponding PDE illustrations as well as various abstract hyperbolic settings in the finite case It presents numerous fascinating results These volumes will appeal to graduate students and researchers in pure and applied mathematics and theoretical engineering with an interest in optimal control problems **Control Theory from the**

Geometric Viewpoint Andrei A. Agrachev,Yuri Sachkov,2013-03-14 This book presents some facts and methods of the Mathematical Control Theory treated from the geometric point of view The book is mainly based on graduate courses given by the first coauthor in the years 2000 2001 at the International School for Advanced Studies Trieste Italy Mathematical

prerequisites are reduced to standard courses of Analysis and Linear Algebra plus some basic Real and Functional Analysis No preliminary knowledge of Control Theory or Differential Geometry is required What this book is about The classical deterministic physical world is described by smooth dynamical systems the future in such a system is completely determined by the initial conditions Moreover the near future changes smoothly with the initial data If we leave room for free will in this fatalistic world then we come to control systems We do so by allowing certain parameters of the dynamical system to change freely at every instant of time That is what we routinely do in real life with our body car cooker as well as with aircraft technological processes etc We try to control all these dynamical systems Smooth dynamical systems are governed by differential equations In this book we deal only with finite dimensional systems they are governed by ordinary differential equations on finite dimensional smooth manifolds A control system for us is thus a family of ordinary differential equations The family is parametrized by control parameters

Systems Theory with Engineering Applications Mihail

Voicu, 2021-09-09 This book presents in a rigorous and comprehensible way the mathematical description and analysis of linear dynamic systems and the controllability and observability of linear dynamic systems It also details the stability of linear dynamic systems automatic control systems and nonlinear dynamic systems and the optimal control of dynamic systems The treatment is both systemic and synthetic achieving rigorous and applicative solutions and is illustrated with engineering examples The book will appeal to scientists working in the practice of systems theory engineering automatic control computer science electrical engineering electronics and applied mathematics in biology and economics as well as scientists working in education research design and industry

Gröbner Bases in Control Theory and Signal Processing Hyungju

Park, Georg Regensburger, 2011-12-22 This volume contains survey and original articles presenting the state of the art on the application of Gröbner bases in control theory and signal processing The contributions are based on talks delivered at the Special Semester on Gröbner Bases and Related Methods at the Johann Radon Institute of Computational and Applied Mathematics RICAM Linz Austria in May 2006

Periodic Feedback Stabilization for Linear Periodic Evolution

Equations Gengsheng Wang, Yashan Xu, 2017-02-08 This book introduces a number of recent advances regarding periodic feedback stabilization for linear and time periodic evolution equations First it presents selected connections between linear quadratic optimal control theory and feedback stabilization theory for linear periodic evolution equations Secondly it identifies several criteria for the periodic feedback stabilization from the perspective of geometry algebra and analyses respectively Next it describes several ways to design periodic feedback laws Lastly the book introduces readers to key methods for designing the control machines Given its coverage and scope it offers a helpful guide for graduate students and researchers in the areas of control theory and applied mathematics

Dissipative Systems Analysis and Control Bernard

Brogliato, Rogelio Lozano, Bernhard Maschke, Olav Egeland, 2006-11-24 Dissipative Systems Analysis and Control second edition presents a fully revised and expanded treatment of dissipative systems theory constituting a self contained advanced

introduction for graduate students researchers and practising engineers It examines linear and nonlinear systems with examples of both in each chapter some infinite dimensional and nonsmooth examples are also included Throughout emphasis is placed on the use of the dissipative properties of a system for the design of stable feedback control laws The theory is consistently substantiated by experimental results and by reference to its application in illustrative physical cases Lagrangian and Hamiltonian systems and adaptive controllers are covered thoroughly The second edition is substantially reorganized both to accommodate new material and to enhance its pedagogical properties

Tautological Control Systems Andrew D. Lewis, 2014-07-22 This brief presents a description of a new modelling framework for nonlinear geometric control theory The framework is intended to be and shown to be feedback invariant As such Tautological Control Systems provides a platform for understanding fundamental structural problems in geometric control theory Part of the novelty of the text stems from the variety of regularity classes e g Lipschitz finitely differentiable smooth real analytic with which it deals in a comprehensive and unified manner The treatment of the important real analytic class especially reflects recent work on real analytic topologies by the author Applied mathematicians interested in nonlinear and geometric control theory will find this brief of interest as a starting point for work in which feedback invariance is important Graduate students working in control theory may also find Tautological Control Systems to be a stimulating starting point for their research

Geometric Control of Mechanical Systems Francesco Bullo, Andrew D. Lewis, 2019-06-12 The primary emphasis of this book is the modeling analysis and control of mechanical systems The methods and results presented can be applied to a large class of mechanical control systems including applications in robotics autonomous vehicle control and multi body systems The book is unique in that it presents a unified rather than an inclusive treatment of control theory for mechanical systems A distinctive feature of the presentation is its reliance on techniques from differential and Riemannian geometry The book contains extensive examples and exercises and will be suitable for a growing number of courses in this area It begins with the detailed mathematical background proceeding through innovative approaches to physical modeling analysis and design techniques Numerous examples illustrate the proposed methods and results while the many exercises test basic knowledge and introduce topics not covered in the main body of the text The audience of this book consists of two groups The first group is comprised of graduate students in engineering or mathematical sciences who wish to learn the basics of geometric mechanics nonlinear control theory and control theory for mechanical systems Readers will be able to immediately begin exploring the research literature on these subjects The second group consists of researchers in mechanics and control theory Nonlinear control theoreticians will find explicit links between concepts in geometric mechanics and nonlinear control theory Researchers in mechanics will find an overview of topics in control theory that have relevance to mechanics

Spacecraft Momentum Control Systems Frederick A. Leve, Mason A. Peck, Brian J. Hamilton, William Bialke, 2025-09-01 With space industry professionals and university students this book offers a practical technical reference for seeking to understand the

state of the art in spacecraft momentum control systems The focus is control moment gyroscope CMG technology but general principles of momentum control for example through reaction wheels magnetic torque actuation and other means are presented These key topics are treated in several contexts systems engineering and spacecraft architecture attitude control and dynamics and mission operations The subject matter is developed with theoretical rigor and in terms of practical implementation in flight hardware software This book is the first to address CMG technology in depth let alone from a practitioner s perspective It is also timely given the rise of commercial Earth imaging the imminent need for high torque manipulation of satellites for servicing and assembly the advances in privately built spacecraft including small satellites and the growing popularity of the subject matter in academia over the past two decades The current edition includes exercises suitable for upper level undergraduate courses and graduate level courses in spacecraft attitude dynamics and control spacecraft design and space systems engineering This second edition provides more applications attitude control momentum and nutation dumping isolation system identification systems engineering bearings and structures as well as more in depth discussions of equations of motion as well as the numerics and complexity associated with generalized inverses that are used for steering algorithms

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